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APPLICATION NUMBER: ***60/145,286***
FILING DATE: ***July 23, 1999***
PCT APPLICATION NUMBER: ***PCT/US00/20099***

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53 (c).

INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
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☐ Additional inventors are being named on the ___ separately numbered sheets attached hereto

TITLE OF THE INVENTION (280 characters max)

ADVANCED LAUNCH AND RECOVERY METHOD FOR UNMANNED AERIAL VEHICLES

CORRESPONDENCE ADDRESS

Direct all correspondence to:

[x] Customer Number 22807 → Place Customer Number Bar Code Label here 22807 PATENT TRADEMARK OFFICE

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ENCLOSED APPLICATION PARTS (check all that apply)

[x] Specification Number of Pages 16 ☐ Small Entity Statement

[x] Drawing(s) Number of Sheets 11 [x] Other (specify) return postcard

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT (check one)

[x] A check or money order is enclosed to cover the filing fees

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FILING FEE AMOUNT ($) $150.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

[x] No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: ______

Respectfully submitted,

SIGNATURE Glenn K. Robbins II

Date 7/23/99

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Docket Number: 64234.88007

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

This collection of information is required by 37 CFR 1.51. The information is used by the public to file (and by the PTO to process) a provisional application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the complete provisional application to the PTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, D.C., 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Box Provisional Application, Assistant Commissioner for Patents, Washington, D.C., 20231.

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July 23, 1999

Box Provisional Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

Re: Provisional Patent application for
ADVANCED LAUNCH AND RECOVERY METHOD FOR UNMANNED AERIAL VEHICLES
Applicant: McDonnell, William R.

Dear Sir:

Please find enclosed for filing the above provisional application with cover sheet and filing fee check in the amount of $150.00

This application is being mailed by U.S. Express Mail under the provisions of 37 CFR §1.10 using Express Mailing Label **275026038US**.

We request that you acknowledge receipt of the application by endorsing the self-address, stamped postcard attached to this letter.

Respectfully,

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Enclosure

Provisional Patent EJ275026038US

Advanced launch and recovery method for Unmanned Aerial Vehicles.

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William R. McDonnell

Assignee: Advanced Aerospace Technologies, Inc., St. Louis, Mo.

Date: 7 June 1999

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ABSTRACT

An improved method of launching and retrieving a

UAV(Unmanned Aerial Vehicle) is disclosed. The preferred method of launch involves carrying the UAV up to altitude using a parasail similar to that used to carry tourists aloft. The UAV is dropped and picks up enough airspeed in the dive to perform a pullup into level controlled flight.
The preferred method of recovery is for the UAV to fly into and latch onto the parasail tow line or cables hanging off the tow line and then be winched back down to the boat.

ADVANCED LAUNCH AND RECOVERY METHOD FOR UNMANNED AERIAL VEHICLES

FIELD OF THE INVENTION

The present invention relates to the methods and mechanisms required to launch and retrieve aircraft from point locations without the use of runways.

BACKGROUND OF THE INVENTION

Previously glider aircraft have been towed aloft and then released to fly off on their own and catapults have been used to rapidly accelerate an aircraft up to flying speed in a short distance. Also aircraft have been fitted with tail hooks or other apparatus to try to engage arresting cables or have been flown into nets in order to arrest their forward movement in a short distance.

Prior art patent number 4,753,400 (Reuter et al) probably comes closest to one of the preferred embodiments of the proposed invention. However this prior art discloses a very complicated system with a launching parachute and parachute retainer that gets jettisoned for each recovery cycle which in turn launchs a ram-air parachute which holds up a ribbon parachute which acts to capture the UAV. A ship mounted stanchion, net and rotating cradle is then required to disentangle the

UAV from the ribbon parachute. In this prior art the UAV engaged the ribbon parachute just below the supporting ram-air parachute and thus providing much less of an arrestment distance and thus higher loads. The UAV approachs in the turbulent, blocked flow from the ribbon parachute and the ribbon parachute also causes a very large amount of unnecessary drag for the system.

There is also another problem with this prior art. Not only is there no apparent mechanism for retaining the UAV after it impacts the ribbon parachute but it would appear that the UAV would tend to bounce off straps 40 in Figure 5 and tend to drop from the ribbon parachute. The current invention is much simpler, more compact, much easier to launch and retrieve, much less susceptible to damage, nothing is jettisoned, etc. Also no prior art including Reuter et al, has envisioned the currently proposed launch approach.

SUMMARY OF THE INVENTION

The present invention provides improvements in the launch and recovery of aircraft from a point location without the need for runways. The preferred method of launch involves carrying the UAV up to altitude using a parasail similar to that used to carry tourists aloft. The UAV is dropped and picks up enough airspeed in the dive to perform a pullup into level controlled flight.
The preferred method of recovery is for the UAV to fly into and latch onto the parasail tow line or a secondary cable hanging from the parasail tow line and then be winched back down to the boat. Although not preferred, a more viable net capturing device for use with a parasailing rig is disclosed. For land use a lighter than air suspended tethered parachute or a tethered tip drive rotor replaces the parasailing rig.

Current state-of-the-art UAV(unmanned aerial vehicle)

launch and arrestment systems are bulky and difficult to integrate onto smaller ships and are time consumming to operate, erect and tear down. In addition the recovery is very sensitive to sea states and ship motion and very often results in damage to the UAV and arrestment system. The recovery also requires significant piloting skills since the UAV must hit the center of the arrestment net in close proximity to the water, ship structure and personnel while traveling at relatively high speeds through the turbulent air wake from the ship.

The proposed system is designed to avoid the previously described problems and also allow launch and recovery of Exdrone class UAVs from vessels down to as small as 25 feet long. The proposed system also offers the potential for other uses such as local area surveillance when no UAVs are operating near by, airborne decoys or antennas for intelligence or communications, etc. by using the parasailing system by itself as an airborne platform

This new launch and arrestment technique takes advantage of modern low cost commercial parasailing technology that is proven, safe, man-rated and can raise and lower passengers directly from the back of a small boat.

For launch the UAV is carried aloft in place of a passenger and released at altitude. The UAV picks up airspeed as it dives and the pilot pulls back on the control stick so the UAV will pullup into level flight. This technique has already been demonstrated with sub-scale aircraft. The release mechanism holds the UAV upright and facing forward into the relative wind and is flexibly attached to the parasail so that vehicle movement can be detected during pilot pre-flights checks to make sure the control surfaces are working.

For recovery the UAV engages the cable approximately half way between the ship and the parasail by deflecting the cable into a latching hook mechanism. The UAV is then reeled back in.

The resulting launch and recovery approach has the following characteristics;

A) <u>Safer, less sensitive to sea states and requires less pilot training</u>
Launch and recovery is performed at a safe altitude away from the water, ship and ship's personnel and if the UAV misses the cable it simply goes around for another attempt. The UAV always approachs into the relative wind (with the parasail providing an excellent cue to the relative wind direction) independent of the ships orientation for minimum closure speed and without having to crab.
With a straight in approach the UAV's forward looking camera can be used for accurate guidance into the cable. The UAV avoids having to fly through the turbulent wake of the ship and is relatively unaffected by the pitching, rolling and heaving of the ship in higher sea states.

B) <u>Less potential for damage</u>
This system arrests the UAV over a greater distance than a conventional net system resulting in lower loads and the loads are applied at one of two known UAV hardpoints. Arrestment loads are inversely proportional to the arrestment distance so that stopping a UAV in 100 feet takes only 10 percent of the loads of stopping it in 10 feet. The launch loads are of course dramatically reduced also. The potential of the UAV impacting the ship or water is greatly reduced and there is no net to be damaged.

C) <u>More compact, easier to deploy, store and operate</u>
The proposed system is compact enough to be used on 25 foot long parasailing boats. Deploying the system consists of running two of the parachute risers up a 10 foot flagpole that causes the chute to open and fill with

air and then the parachute is reeled out. To store the system, the parachute is reeled back in and the two upper risers are pulled down to deflate the chute. The parachute need not be carefully folded and typically the risers are chain knotted and then the chute is stuffed in a bag.
Unlike a net system the UAV after arrestment doesn't need to be dis-entangled from a net.

It is an object of the invention to provide a compact, inexpensive, lightweight method of launching and retrieving conventional UAVs from a point location.

It is a further object of the invention to get the arrestment mechanism up above any objects the UAV might otherwise run into and above any turbulent air from objects near the ground such as the ship's superstructure, trees, etc.

It is an additional objective of the invention to provide a launch and recovery system that exerts lower loads and inflicts less damage to the UAV and arrestment system.

It is an additional objective of the invention to provide an arrestment system that is less effected by heavy seas and the pitching, heaving and rolling of the recovery ship.

It is an object of the invention to provide an arrestment system that achieves a firm latched engagement and is easier to disengage the UAV from the arrestment system after recovery.

It is an objective of the invention to provide a launch and arrestment system that can also provide other functions such as carrying sensors or antennas aloft for local area surveillance, communications or electronic intelligence or warfare.

It is a further object of the invention to utilize normal aircraft structure such as wings and fuselages to guide the arrestment cable into engagement with a latching hook mechanism in order to avoid the weight of a dedicated mechanism for this purpose.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of one embodiment of the invention showing the launch approach;

FIG. 2 is an isometric close up view of an alternative launch configuration.

FIG. 3 is a plan view looking down on an unmanned aircraft designed to be launched and retrieved with this invention. A portion of the release mechanism used for launch is also shown;

FIG. 4 is a side view of one embodiment of the invention showing the arrestment approach.

FIG. 5 is a plan view of FIG. 4.

FIG. 6 is a plan view of some other aircraft configurations for this invention;

FIG. 7 is a frontal view of additional aircraft configurations for this invention;

FIG. 8 is a side view of additional aircraft configurations for this invention;

FIG. 9 is an isometric view of a net system attached to the parasail tow line designed to capture an unmanned aircraft.

FIG. 10 is FIG. 9 just after capturing a UAV

FIG. 11 is a variation on the invention for recovery of UAVs on land.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now by reference numerals to the drawings and first to FIG. 1, one of the preferred embodiments comprises a boat 2, a tow line 4, winch 6, parachute 8, plastic barrel of water as a weight 9, unmanned aerial vehicle(UAV) 10 and release mechanism 12. The launch procedure starts by inflating the parachute 8 which can be done by raising risers number 1 and 16 (not shown) with a flagpole designed for this purpose which is well known in the art or

by having two sailors hold up the separated riser bundles until the chute inflates in the wind. Because conventional parasailing parachutes need a weight hanging under them to keep them oriented properly, a barrel of water 9 or other weight is attached where a tourist would normally be attached to go up parasailing which is well known in the art as a method used for training people to operate parasailing equipment. The UAV 10 attached to the bottom of release mechanism 12 is then attached to the tow cable 4 as shown in Figure 2 for use off of small boats or to the bottom of the barrel 9 as shown in FIG. 1 for use on larger ships where the winch wants to be on top of the hangar but the UAV wants to be attached to the system from the landing deck below. The winch 6 then reels the parachute out until the UAV has reached sufficient altitude for a launch. As the UAV is approaching launch altitude the remote pilot can verify the proper operation of the flight controls by moving the UAVs control surfaces and watching the vehicle respond which is facilitated by the airflow and flexible mounting of the UAV.

A signal is then sent to the release mechanism 12 either through an electrical line in the tow line 4 or a radio signal. The mechanism that releases the UAV consists primarily of actuator 14 and pin 16 which engages UAV mounted bracket 22 as shown in FIG. 3. UAV 10 is held up only by pin 16 passing through a hole in bracket 22 which is part of the UAV but sticks up above the UAVs outer moldline and into a slot in the bottom of the release mechanism structure. For clarity the release mechanism structure and attachment of the release mechanism to the tow line 4 or barrel 9 is not shown in FIG. 3. It will of course be understood that the release mechanism could also be part of the UAV 10 as opposed to being attached to the parasail system.

To release the UAV, actuator 14 pulls pin 16 out of UAV mounted structural bracket 22 allowing the UAV to fall.

The UAV picks up speed in a dive and the pilot pulls back on the control stick so the UAV will do a pullup into level controlled flight. The pilot performs a mild turn so as not to run back into the tow line 4.

For the arrestment and recovery of the UAV, the vehicle runs into the tow line 4 or another line or lines 20, 21 hanging directly or indirectly from the tow line 4 as shown in FIG. 4. As shown in FIG. 3, the tow line 4 contacts the leading edge of the UAV 10 and is deflected out to the wingtip where it engages a hook 26 and spring loaded latch 28 which deflects out of the way and then snaps closed to trap tow line 4 inside hook 26. The hook 26 may have a forward swept extension 30 on the outboard side that could first deflect the cable inboard before engaging the hook 26. Latch 28 is spring loaded to deflect out of the way and then spring back to trap the tow line 4 in hook 26. For tractor propeller UAV configurations such as shown in Figure 3 a propeller guard 32 may be used to deflect the line 4 around the propeller.

For UAVs with swept back leading edges the latching hook 26 and 28 are generally located near the wingtips. As the UAVs get larger and heavier the wingtips generally become less capable of sustaining the arrestment loads without structural beefup and a different approach becomes more desireable. FIG. 6 shows a number of UAV configurations designed to deflect the cable in to the wing root which is very close to the center of gravity and where the structure is naturally very strong. For example a forward swept wing will naturally tend to deflect the tow line 4 in toward the wing root area. The UAV configuration in the upper right hand corner of FIG. 6 has a forward swept wing out to about half span and the configuration in the lower right hand corner achieves the same effect by adding forward pointing rods 34 and wires 36 to deflect the cable into the latching hook at the wing root. For stowage onboard ship it can be desireable to have a UAV where the wing can be rotated 90

degrees to lay flush over the fuselage. For this kind of configuration just prior to arrestment, the wing could be rotated approximately 45 degrees such as shown in the upper left hand corner of FIG. 6 in order to direct the tow line 4 into a latched engagement by the wing root. An equivalent forward swept snare arrangement using the side of the fuselage and one of the wings can also be achieved with a straight winged aircraft as shown in the lower left corner of FIG. 6. This can be achieved by yawing or side-slipping the vehicle with the rudder prior to engagement and/or by intersecting the tow line 4 by flying perpendicular to the direction of travel of the parachute and tow line 4 as shown by flight path arrow 38 in FIG. 5. In the latter approach the movement of the tow line 4 in the direction indicated by flight path arrow 40 in FIG. 5 provides the same effect as some yawing of the aircraft to help drive the cable in to the aircraft's wing root area. A rear view of a UAV 42 in FIG. 4 is shown in a side-slip while on a perpendicular flight path 38 prior to engagement with tow line 4. It can be seen that the rolled attitude to achieve the side-slip also places the wings at a favorable more perpendicular angle to the tow line 4 for the largest capture envelope. In all the configurations described so far the UAV is designed to deflect a cable laterally inboard or outboard relative to the UAV and into engagement with a latching hook. It is also understood that it is possible to design a UAV to deflect a cable vertically relative to the UAV into a latching hook using for example an upper surface hook such as disclosed in Belleville 1,731,091 or a tail hook 70 or vertical tail surface latching hook 72 as shown in Figure 8 side view of a UAV 74. An aft view of UAV 74 in Figure 4 shows how it would engage the tow line 4 with its wings banked at the same angle as the slope of the tow line 4 and with the UAV 74 in a sideslipe and approaching the tow line 4 from the side such as flight path 38 as shown in FIG. 5.

It will also be understood that the UAV can engage the tow line 4 directly or can engage one or more other arrestment

lines 20 and 21 as shown in Figure 4 hanging down from the tow line 4 directly or a beam mounted on the tow line 4.

The kinetic energy of the UAV during an arrestment is dissipated primarily through aerodynamic drag, friction on the tow line 4 and gravity with the amounts varying based on which arrestment approach is used. Arrestments can be made with the vehicle intersecting the tow line 4 or secondary arrestment lines 20,21 approximately perpendicular (which is the preferred approach) or approximately parallel or somewhere in between.

Referring to FIG. 4, flight path 42 achieves a perpendicular engagement by doing a pull up or sustained climb prior to engagement. If a pullup is used, the pilot might time the maneuver for example by using the forward looking camera to fly at a point 60 marked on the tow line 4 until another point 62 is at the top of his video screen at which point he would do a pullup to intersect the tow line 4 just below point 62 or some other marked spot on the tow line 4. A perpendicular engagement can also be achieved with a level flight path in three additional different ways. First, prior to engagement the winch can be released so the cable plays out very rapidly and the tow line 4 hangs near vertical below the parachute. The UAV 10 then engages the cable from behind and swings up and forward on the cable and the winch then takes up the slack. Modern winchs can reel in at very high speeds. Also modern parasailing winchs will automatically reel out at a pre-set braking force if the load in the tow line 4 exceeds the pre-set force level.

A second approach to achieve a perpendicular arrestment from level flight is for the UAV to engage secondary lines 20,21 hanging down relatively straight from the tow line 4. This is probably the preferred configuration for most situations since the winch and launch platform for the parachute can be on top of the ship's hangar where the wind is unobstructed but the recovered UAV when

winched back in will be hanging down lower and thus brought down onto the flight deck below. For a heavy UAV, line 25, as seen in FIG. 4, can be disconnected from tow line 4 at point 47 and taken by a crew member inside the hangar and attached to a winch so the UAV 51 can be winched into the hangar or out for launch without even touching down on the flight deck since it would still be suspended from line 21 on one side and line 25 inside the hangar. For a small boat, line 25 could be used to pull the UAV forward to the back of the boat before it would otherwise land in the water behind the ship.

A third approach to achieve a perpendicular engagement from level flight is to fly into the tow line 4 primarily from the side as shown by flight path 38 in FIG. 5.

Flight paths 46, 48 and 50 are examples where the UAV intersects the tow line 4 at a near parallel angle.

Flight paths 52 and 54 are examples of intersecting the arresting cables at an intermediate angle.

FIG. 7 shows some UAV configurations designed to intersept the arresting cable at a near parallel angle. The UAV configuration on the top of FIG. 7 is designed so the wing would deflect any cables to the centerline latching mechanism that it flies up into or alternatively the landing gear struts would deflect any cables to the centerline latching mechanism that the UAV flies down onto or visa-versa if the vehicle were flown upside down for engagement. The UAV at the bottom of FIG. 7 is designed to deflect a cable to a centerline latching mechanism with its wing. Other configurations are of course possible, for example the cables could be deflected to wingtip latches, dedicated deflecting structures could be used, etc.

There are several approaches to prevent the UAV from sliding all the way down the tow line 4 or sliding down and

off the secondary arrestment cables 20,21.

The first approach is to have the throat of the latching hook 26 smaller than the diameter of the tow line 4 so as to generate a sufficient amount of braking force. In addition the throat of the latching hook could be spring loaded closed to provide a consistent clamping and thus braking load on the tow line 4 independent of tow line 4 diameter. One approach is to have the diameter of the tow line 4 equal to or smaller than the throat of the latching hook 26 at the point of engagement so that the initial braking force is the co-efficient of friction times the normal force of the line pulling against the hook but the line might increase in diameter as the UAV slides down the line resulting in a slowly increasing braking force. Significant braking can still occur even though the tow line 4 is smaller in diameter than the throat of the latching hook 26 especially as the UAV and the latching hook 26 turns so its not lined up perfectly with the tow line 4.

Also as the UAV slides down the tow line 4 the slope of the tow line 4 gets shallower and the UAV naturally slows down. The captain can also slow down the boat even to the point that the tow line 4 goes horizontal or sloping back up as the UAV slides down the tow line 4 toward the boat. Tourist parasail operators have such good control that they often bring the parasail rider down and get only his feet wet before raising him back up again.

Another approach is to have a fixed or sliding stop on the tow line 4 which would also be padded to reduce any shock loads as the UAV contacts the stop. A sliding stop could be designed to provide a fixed amount of clamping or braking force on the tow line 4 or might just be a padded material wrapped around the bottom 30 feet of the tow line 4.

For the preferred configuration where the secondary arrestment cables 20,21 are used, they have a fixed stop on

cables 20, 21 to prevent the UAV 10 from sliding off the bottom ends and the cables 20,21 at the top end could either be rigidly attached to tow line 4 or could attach to tow line 4 through a sliding attachment which like a sliding stop is designed to brake against tow line 4 and absorb any kinetic energy parallel to the direction of travel of the tow line 4. The preferred arrestment flight path for this configuration is shown by flight path 38 in FIG. 5.

It is also understood that cables 20,21 could be replaced with a net system such as shown in Figure 9. Net 100 is hung from tow line 4 as seen in this isometric view and the UAV uses a lateral flight path such as 38 to intersept the net 100 at near right angles at the center 101 of the net. The very open mesh doesn't let the UAV pass through but lets it wedge into one of the holes. A cable 102 is attached at 104 and 106 to the left upper and left lower end of net 100. Likewise cable 108 is attached at 110 and 112 to the upper and lower right corner of net 100. Cables 102 and 108 pass loosely through low friction teflon loops 120 and 122 which also acts as a quick disconnect interface to tow line 4. Cables 102 and 108 can easily slide in loops 120 and 122 and these loops 120 and 122 can also slide along tow line 4 but with a moderate level of friction. From the UAV engagement, the net 100 is driven laterally away from the tow line and into a position shown in FIG. 10 where the net 100 has encapsulated the UAV 124. Although probably not necessary, the cables 102 and 108 could also be designed like tie wraps on garbage bags so the force of the engagement would actually pull the opening 130 of the net closed shut.

Overloading the tow line 4 or the parachute is not a problem for this invention because they would be over-designed for the loads in the same manner as current parasailing equipment. The parachutes typically have 16 risers with each riser capable of an approximate 900 lb load. The load on the tow line is typically arount 900lbs but is

typically capable of carrying 6 or 7000lbs. The parachute movement in response to loads also provides a very large shock absorbing capability and modern winchs on the ship can be set to automatically play out when loads exceed a certain amount. Although not considered necessary it is also possible to add a bungee cord into a section of the line below the parachute.

A little different approach is preferred for land based use since you can't count on having an unrestricted area to pull a parasailing rig around with a ground vehicle. As a result a lifting system is desired that doesn't rely on always having a relative wind. One approach is to have a tip drive rotor which is supplied high pressure air up through the tether, out the blades and ejected tangentially to power the rotor as is known in the art or uses gas pressure from rocket propellant cartridges onboard to drive the rotor. This provides a lot of lift with a light, compact and simple airborne unit. Another approach is to have the lifting system be a wire strung between two support members that the arresting cable hangs down from and can slide along similar to that disclosed in Belleville 1,731,091 or a rotating arm similar to Koper 4,311,290. Another approach is to use lighter than air such as helium or hot air as the lifting system. A lighter than air approach gets very large however unless it is used just for recovery and preferably in combination with a parachute type system. FIG. 11 shows one such approach where the lighter than air balloon and lifting parasail are integrated together. A lighter than air balloon 64 has vertical tail fins 66 to keep the balloon oriented into the wind if there is any. Risers to hold the balloon down covered by parachute material 68 is attached to each side of the balloon 64. A tether line 82 connects to the bottom of the balloon 64 and parachute 68 system which in turn is attached to the ground or for a large system a drum 84 for retracting the system down through the open roof of trailer 86 for transporting. Part way up the line is air inflated cushion 88. For an

arrestment the roof of the transporter is opened and the balloon 64 is allowed to rise to a point above any obstructions such as trees 90. UAV 80 flies into and engages tether line 82 below balloon 64 and above cushion 88. Due to the wind if any and the translational speed after UAV 80 engagement, the parachute material 68 deflects out and inflates providing the primary source of lift and drag of the system to slow the translational speed of the UAV 80 and provide a low descent rate. The UAV 80 slides down the cable 82 until it rests on top of air cushion 88 which is large enough to cover the entire underside of the UAV 80 and cushion the impact with the ground. The lighter than air balloon 64 keeps the parachute up out of the bushs and keeps the parachute aligned into the wind where its generating as much or more lift than drag so it will be less likely to drag the UAV 80 along the ground. However if this becomes a problem in heavy winds the winch could reel the UAV in to land on the top of the padded trailer and a padded cushion 88 on the line 82 wouldn't be required.

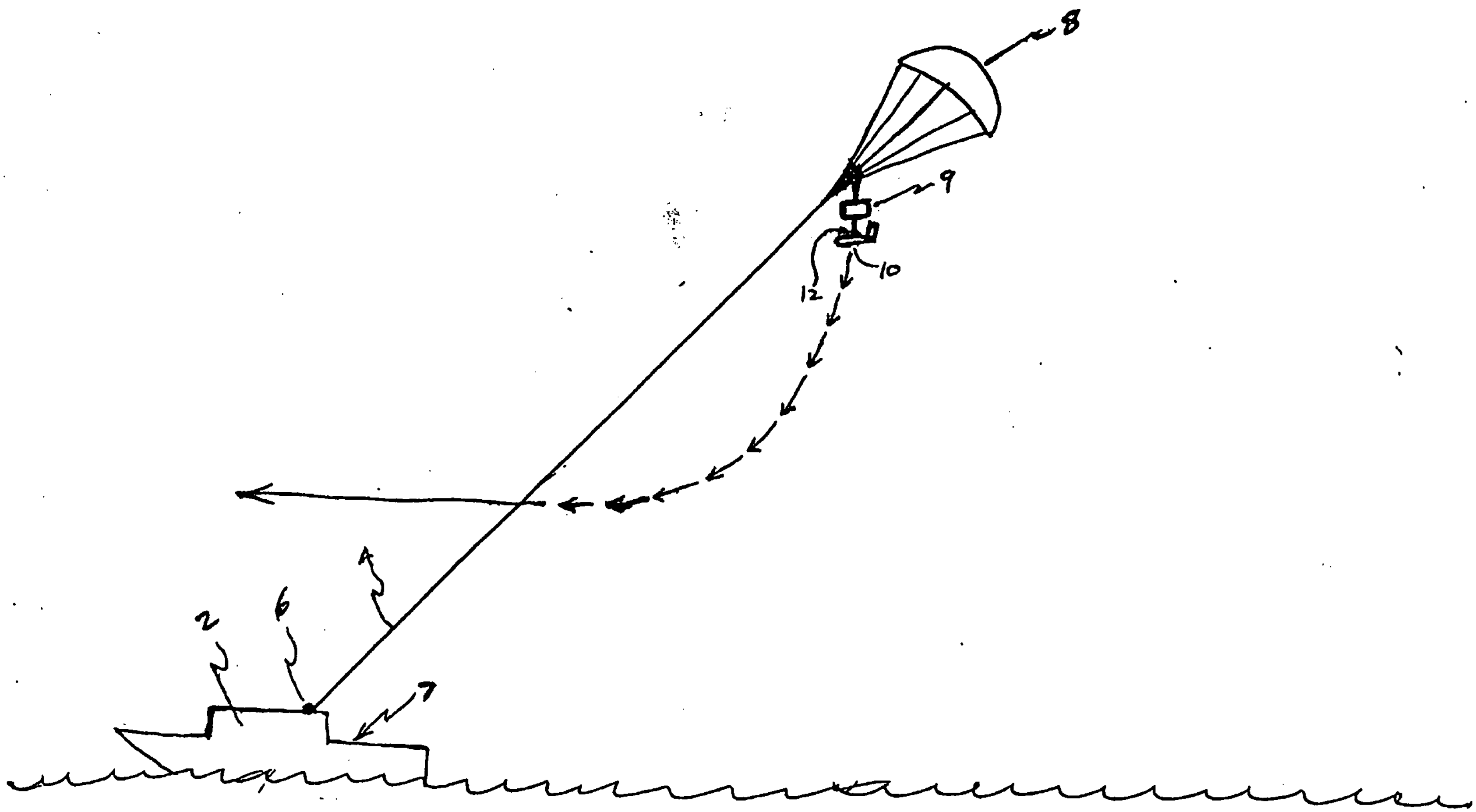

FIGURE 1

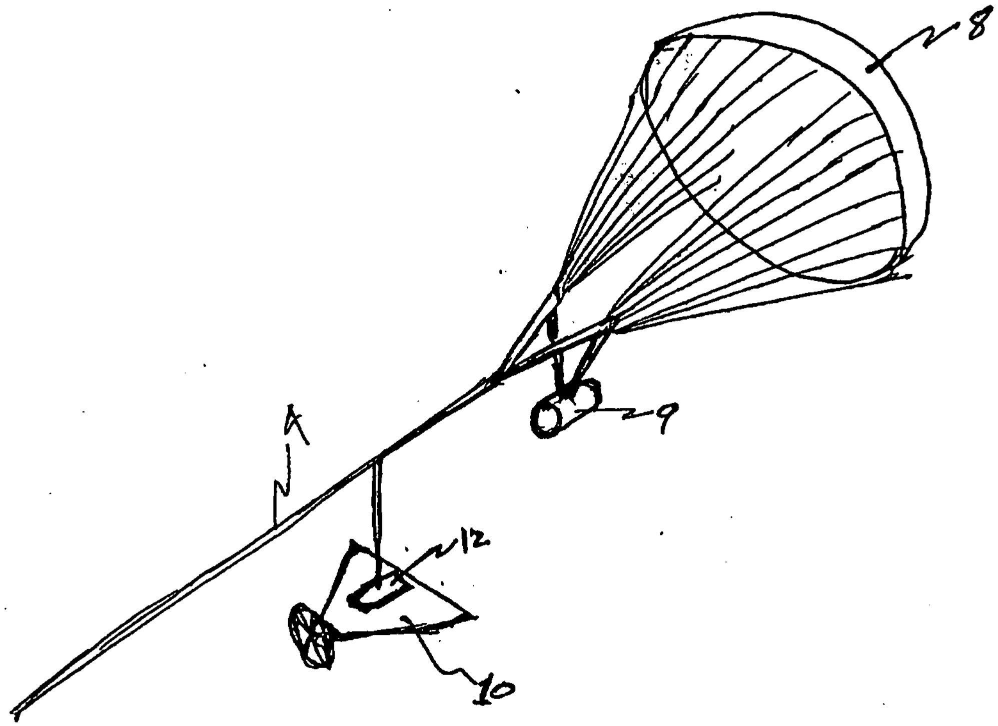

FIGURE 2

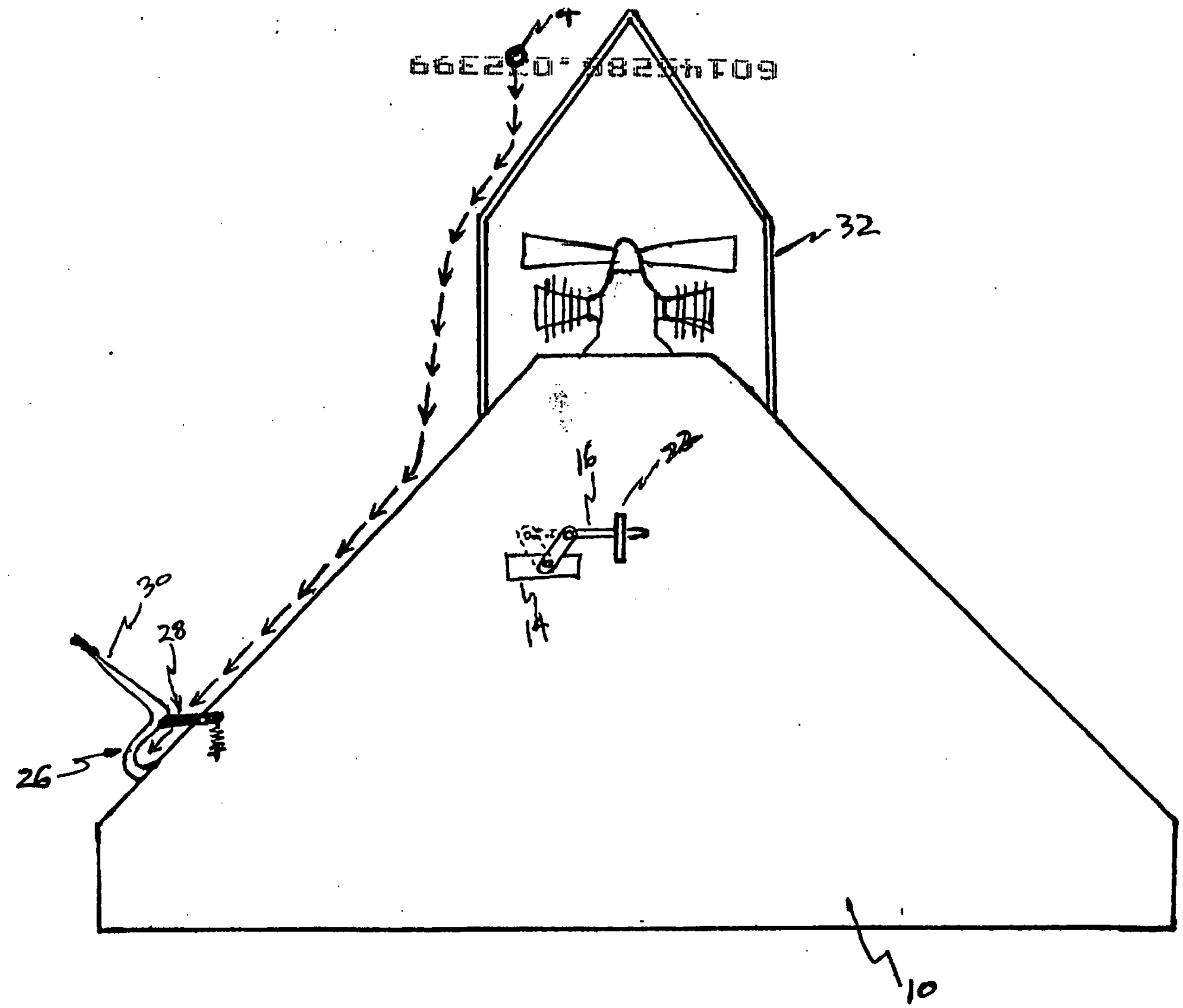

FIGURE 3

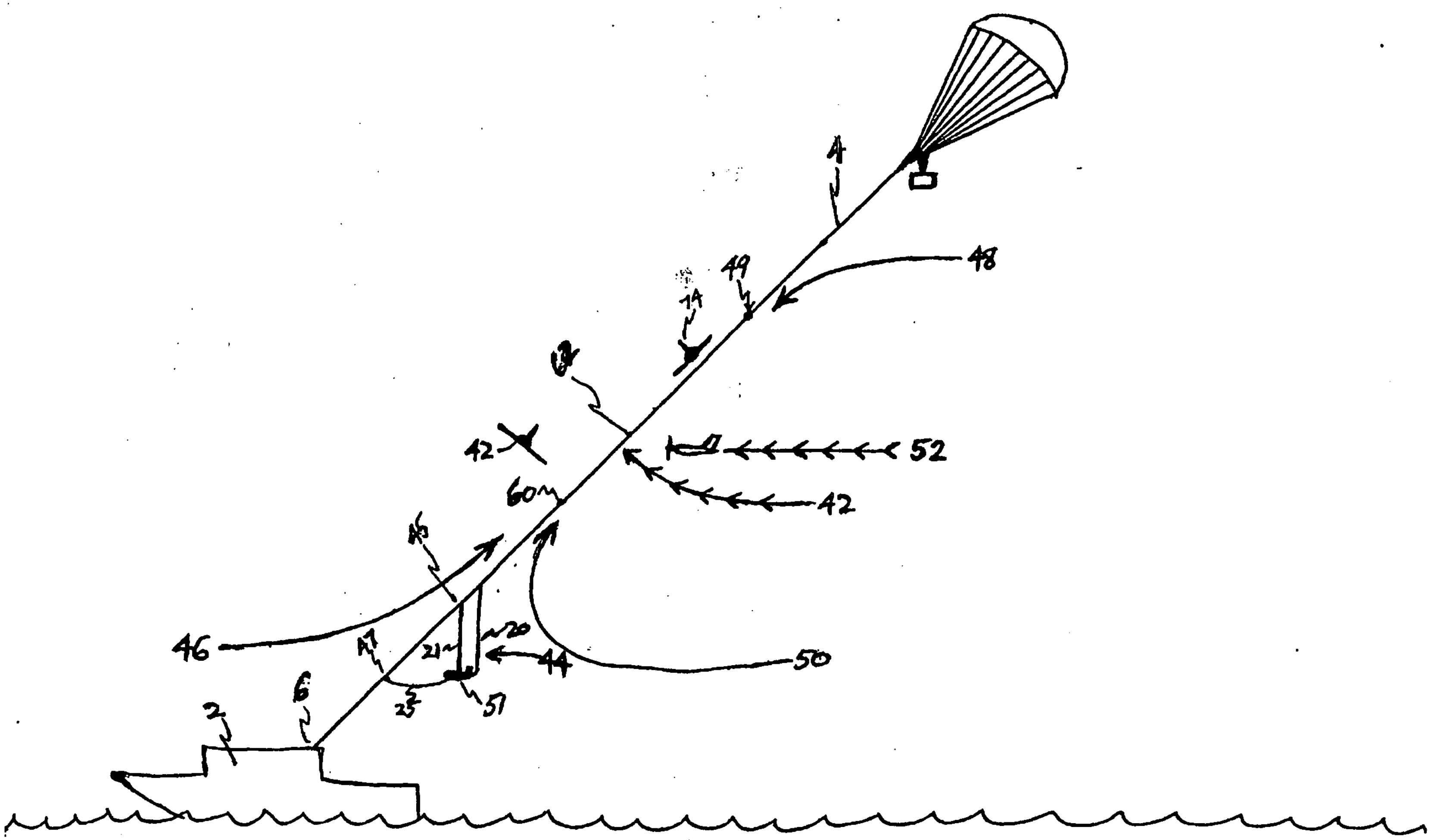

FIGURE 4

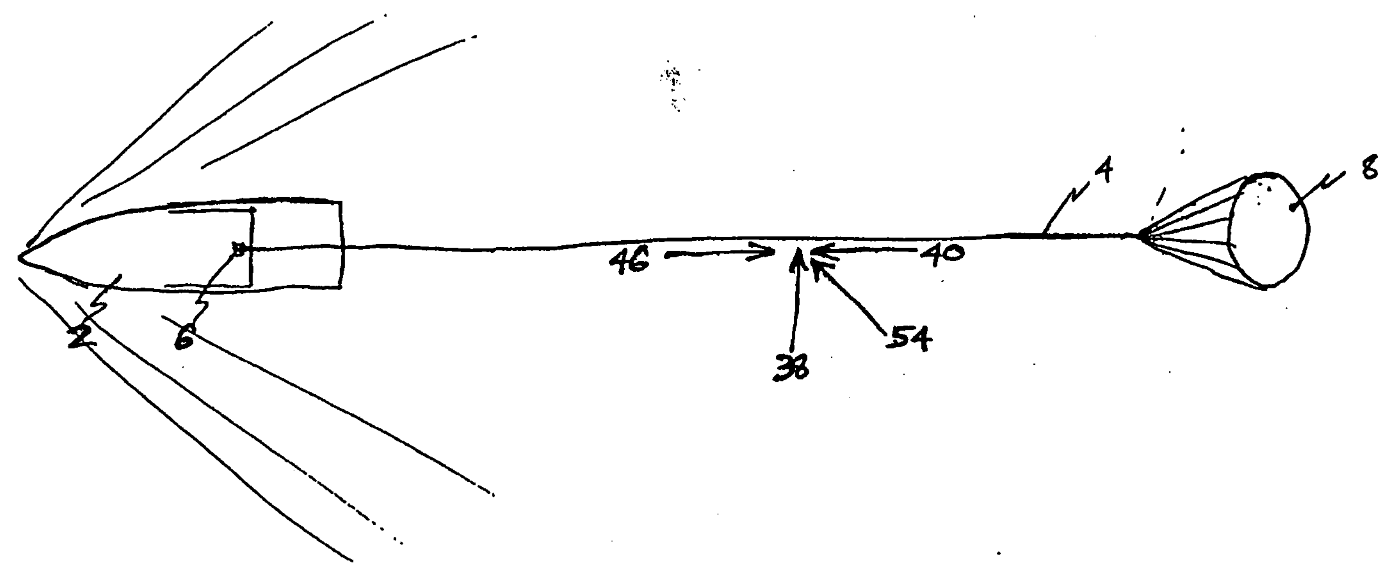

FIGURE 5

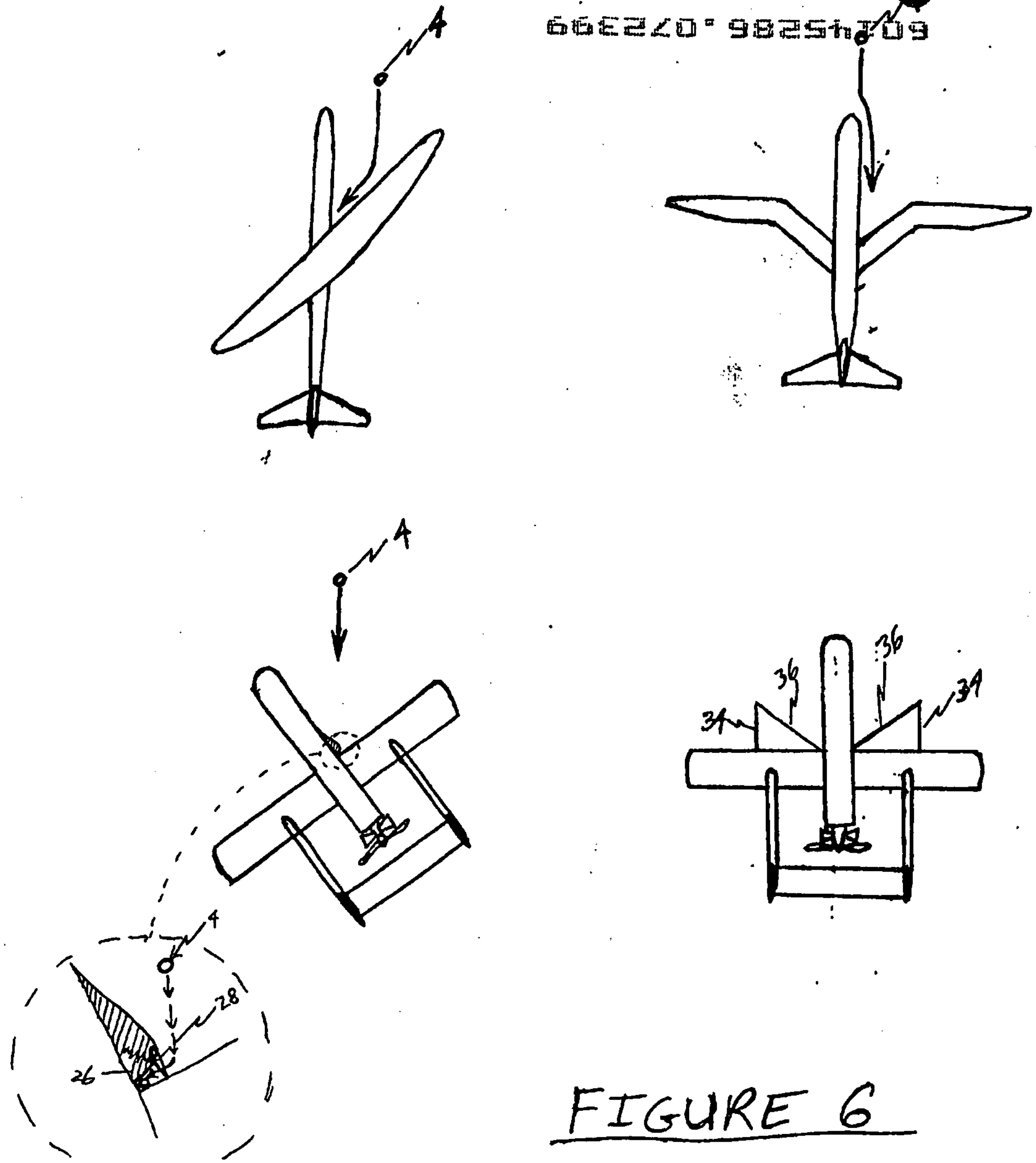

FIGURE 6

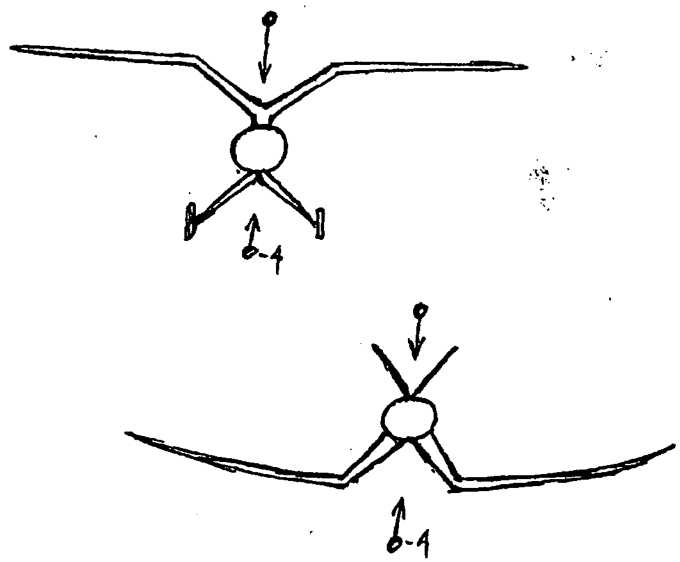

FIGURE 7

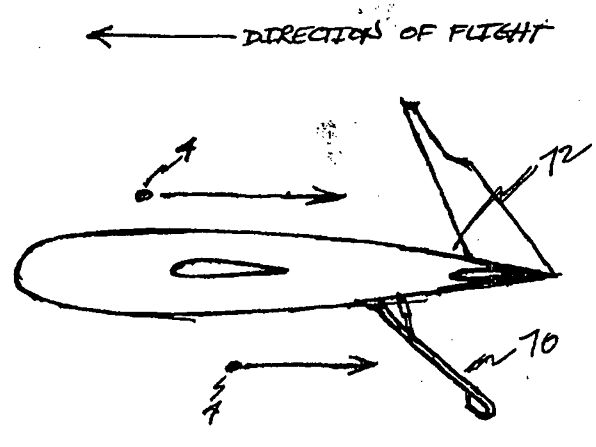

FIGURE 8

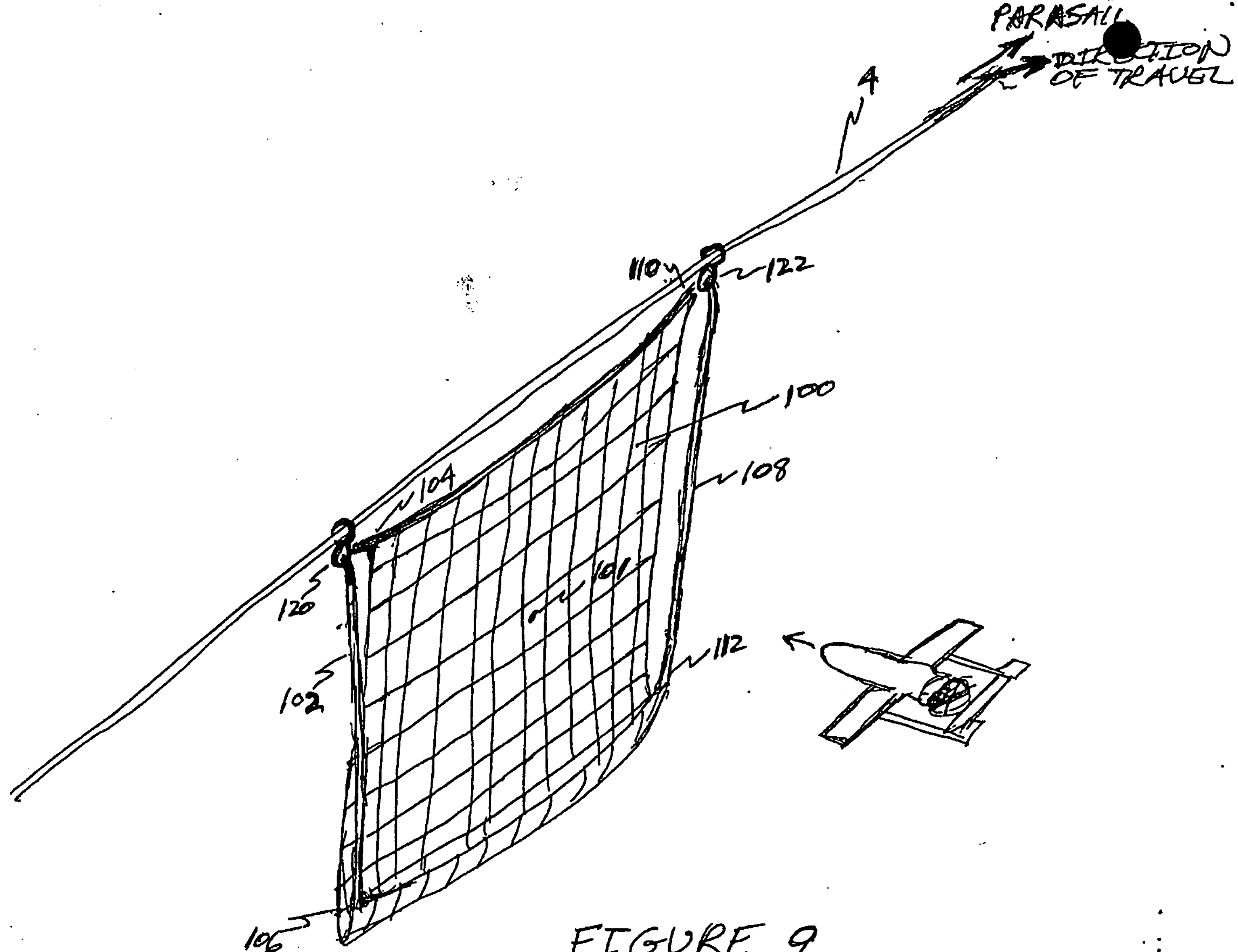
PARASAIL
DIRECTION OF TRAVEL
4
110
122
100
108
104
101
120
102
112
106

FIGURE 9

60145286.072399

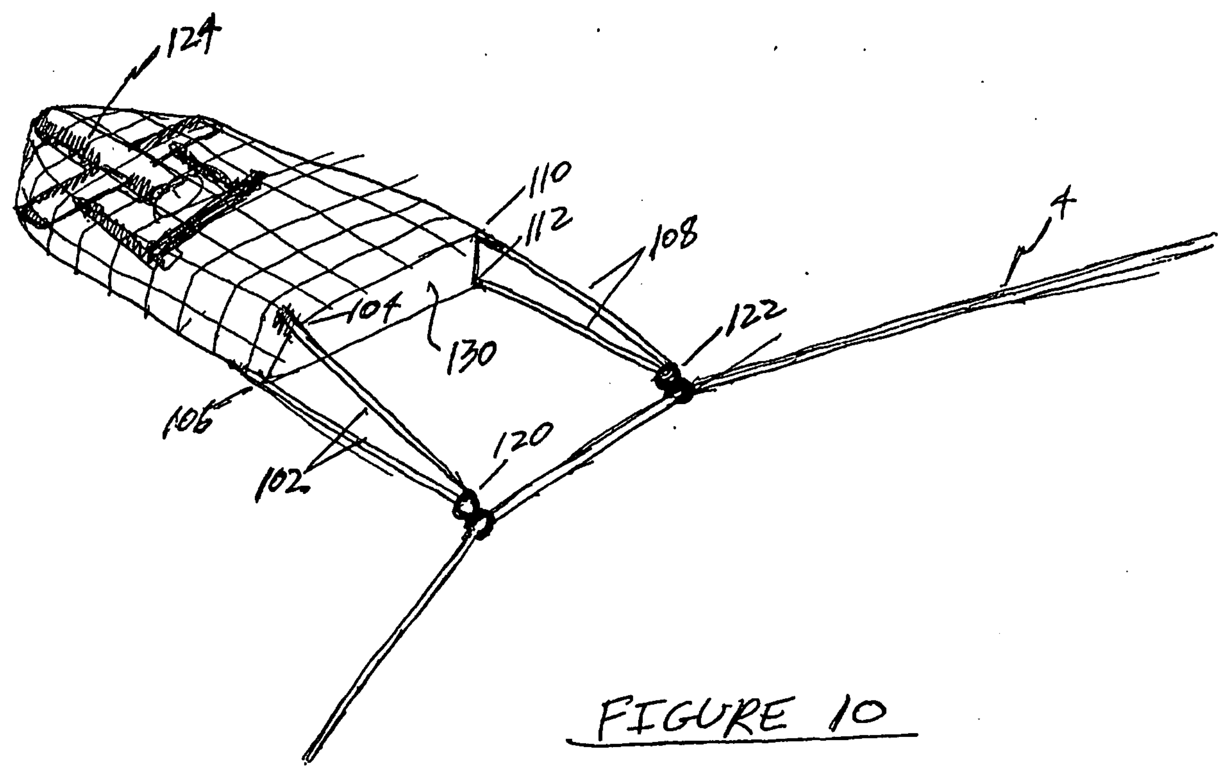

FIGURE 10

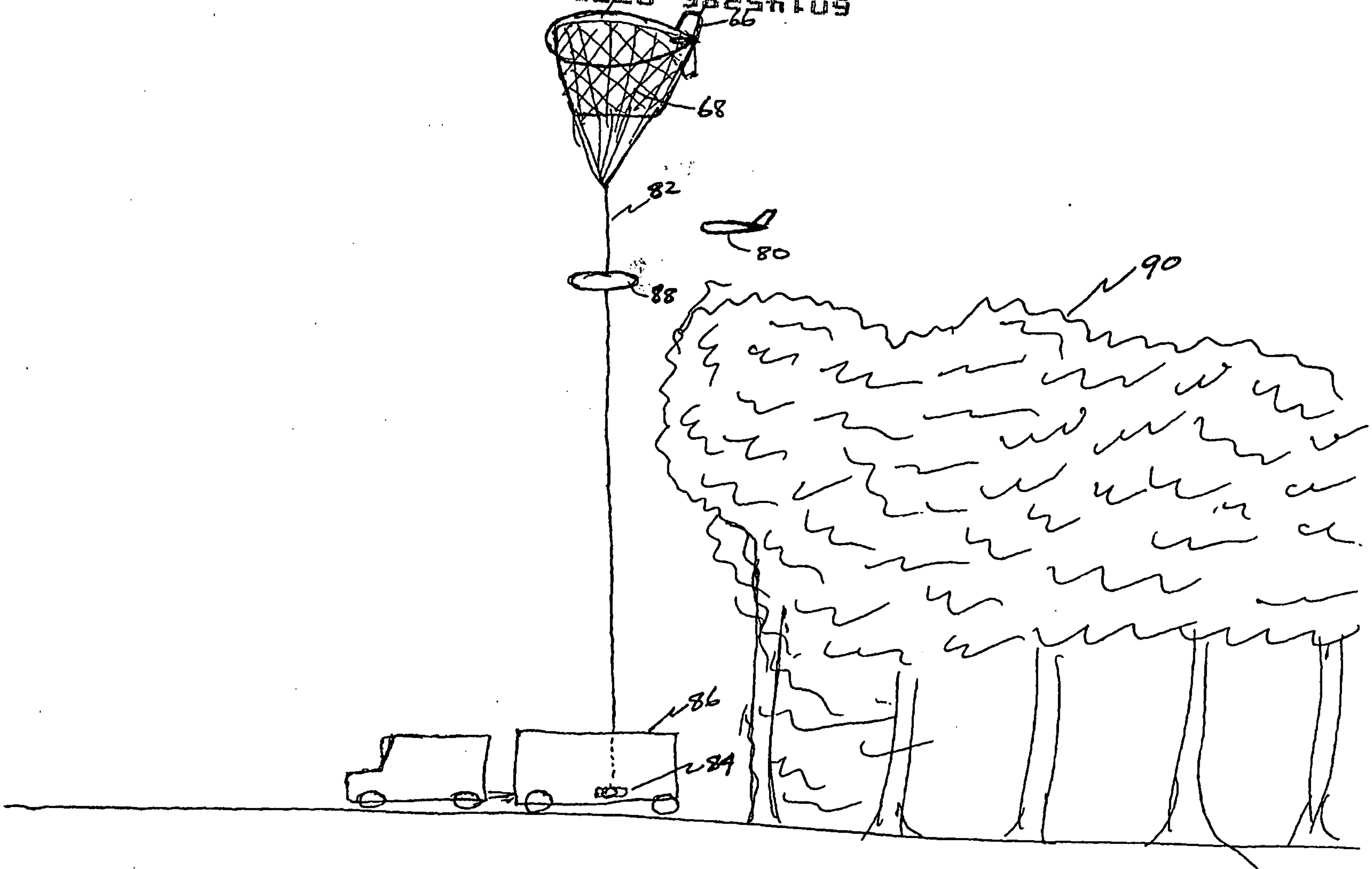

FIGURE 11